

# Auxiliary and Supplemental Power Fact Sheet: Solar Cells

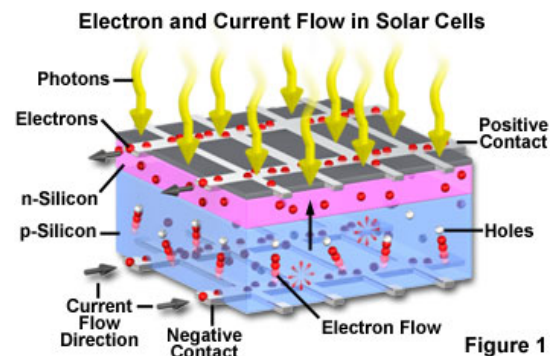
## DESCRIPTION

This fact sheet describes the use of solar cells, which are otherwise known as photovoltaic (PV) cells, as Auxiliary and Supplemental Power Sources (ASPSs) for wastewater treatment plants (WWTPs). PV cells convert sunlight directly into electricity. They are often assembled into flat plate systems that can be mounted on rooftops or other sunny areas.

A PV cell is composed of several layers of different materials. The top layer is a glass cover or other encapsulating material designed to protect the cell from weather conditions. Underneath this is an anti-reflective layer that prevents the cell from reflecting sunlight away. Beneath this layer are two semiconductor layers, typically made from silicon. A set of metallic grids or electrical contacts is placed around the semiconductor material, one above the material and the other below. The energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose from the semiconductor, allowing them to flow freely. An electric field within the PV cell forces the freed electrons to move in a certain direction. The top grid, or contact, collects the flowing electrons from the semiconductor. The bottom contact layer is connected to the top contact layer to complete the electrical circuit. This flow of electrons is the current, and by placing metal contacts on the top and bottom of the PV cell, that current can be drawn off to be used externally. This current, together with the cell's voltage (which is a result of the strength of its built-in electric field), defines the power (or wattage) that the solar cell can produce.

Commercially available PV modules are about 5 to 15 percent efficient at converting sunlight into electrical energy, and can produce from 1 to 100 kilowatts (kW) of electrical energy. An individual PV cell will typically produce between one and two watts. To increase the power output, several cells can be interconnected to form a module. Similarly,

modules can be connected to form an array. A photovoltaic array with a surface area roughly the size of two football fields could produce 1000 kW of peak power. Ideally, a backup storage system should be included with the PV system to store power so that it can be used during low light conditions or at night.



## ADVANTAGES & DISADVANTAGES

### Advantages

There are several advantages to using solar cells. They generate electricity with no moving parts, they operate quietly with no emissions, and they require little maintenance, and are therefore ideal for remote locations.

### Disadvantages

PV cells require adequate sunlight to charge, and thus they are dependant on good weather. They may also be inefficient in some geographic locations that do not receive adequate levels of sunlight throughout the year. They can require very large areas if they are required to generate large amounts of power. Although solar cells require very little maintenance, they can be difficult to repair when maintenance is needed. Also, the initial cost of solar cells is very high.

## **COST**

Currently PV systems cost from \$6,000/kW to \$10,000/kW installed. The cost of a PV system depends on the system's size, equipment options and installation labor costs.

The average factory price of PV modules is about \$4/watt, excluding balance-of-system (BOS) costs. BOS costs increase the factory costs by 30-100 percent. Major BOS cost items include control equipment (maximum power point trackers, inverters, battery charge controllers), PV array support structures, battery storage (if present), installation and associated fees, insurance, and data acquisition system and sensors.

Solar system costs have declined dramatically over the past 20 years. In the early 1980's, system costs were more than \$25/watt. Costs are expected to be about \$2/watt by 2010.

## **CASE STUDY**

Oroville, a town of 12,000 in Northern California, operates a 6.5 MGD WWTP. In 2002, amidst an energy crisis that saw the price of utilities rise 41 percent, the Oroville Sewage Commission (SC-OR) decided to pursue solar array as a solution to reduce costs and increase energy self-reliance. In November 2002, the utility completed installation of a 520-kW solar system, and SC-OR was able to reduce its power costs by 80 percent. The system is a ground-mounted array that can be manually adjusted seasonally to maximize the solar harvest. The system is designed to produce more power than SC-OR needs during peak hours, and because the system is connected to the local energy grid, it can feed all of the excess energy back to the power utility so that SC-OR can receive credit on their power bill. This credit goes toward paying for the off-peak power that the treatment plant uses at night. SC-OR saved \$58,000 in the first year and expects the solar array to pay for itself in 9 years. The installed cost for the system was approximately \$4.7 million, with a rebate to the utility of \$2.3 million from The Self-Generation Incentive Program of Pacific Gas and Electric (PG&E) and managed through the California Public Utilities Commission (CPUC).



**Large Solar Panel Array**

## **REFERENCES**

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EPA 832-F-05-011

Office of Water

March 2005